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AF/SSD-TR-61-7

R-3134

HYDRAZINE HANDLING MANUAL

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

6633 CANOGA AVENUE, CANOGA PARK, CALIFORNIA

CONTRACT AF33 (616)-6939

PROJECT No. 3148

TASK No. 30196

SEPTEMBER 1961

ROCKET TEST ANNEX

SPACE SYSTEMS DIVISION

AIR FORCE SYSTEMS COMMAND

UNITED STATES AIR FORCE

EDWARDS AIR FORCE BASE, CALIFORNIA

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FOREWORD

This manual is one of the four propellant handling manuals prepared under Contract AF33(616)-6939, Supplement 1, PN 3148, TN 30196. The administrative and technical direction of this effort was provided by Messrs. F. S. Forbes, T. Marshall, and J. H. Smith of the AFFTC, Edwards Air Force Base, California. The manuals were prepared by the Analysis and Equipment Group of the Rocketdyne Engineering Department.

The propellant handling manuals were titled and identified as follows:

AF/SSD-TR-61-7	Hydrazine Handling Manual
AF/SSD-TR-61-8	Nitrogen Tetroxide Handling Manual
AF/SSD-TR-61-9	Chlorine Trifluoride Handling Manual
AF/SSD-TR-61-10	Pentaborane Handling Manual

A group of four design-criteria manuals were also prepared under Contract AF33(616)-6939, Supplement 1, PN 3148, TN 30196. These manuals were titled and identified as follows:

AF/SSD-TR-61-6	Mechanical System Design-Criteria Manual for Hydrazine
AF/SSD-TR-61-5	Mechanical System Design-Criteria Manual for Nitrogen Tetroxide
AF/SSD-TR-61-4	Mechanical System Design-Criteria Manual for Chlorine Trifluoride
AF/SSD-TR-61-3	Mechanical System Design-Criteria Manual for Pentaborane

ABSTRACT

This manual presents directly usable information for the safe handling of hydrazine. The properties of the propellant and techniques for hazards reduction and control are discussed in detail. Selection and preparation of equipment for use with the propellant are also presented and discussed. Propellant transfer procedures using both gas pressurization and pumping techniques are discussed in detail. Other pertinent information such as transportation, storage, and equipment decontamination are also presented.

(Unclassified Abstract)

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INTRODUCTION

This manual presents directly usable information for the safe handling of hydrazine. The material presented is that evolved from both applicable experience and a thorough evaluation of the available literature, especially that originating from the propellant manufacturer.

The need of reliable information for the safe handling of high-energy propellants is self-evident. Although pertinent literature abounds, the application of the published handling techniques to actual situations cannot be successfully realized in most cases. This frustrating situation can be attributed to the fact that most propellant handling information is obtained as a byproduct of hardware development programs. This manual represents one of the first concerted research efforts to formulate safe propellant handling techniques.

The material covered in this manual is that which is considered essential for the safe handling of the propellant. This material is presented in a very simple and direct manner to make it usable to all personnel involved in propellant handling operations. In addition, the techniques included are expected to provide additional background to the designer of storage and handling systems for hydrazine.

The safety practices in the manual are based on the principle that the prevention of hazardous situations is the most important consideration for the safe handling of high-energy propellants. However, it is acknowledged that a completely hazard-free facility cannot be ultimately realized; therefore, serious consideration is also given to the control of any hazardous situation that may arise.

This manual consists of eleven sections, each section dealing with a specific subject such as properties of the propellant, materials of construction, handling procedures, and others. This arrangement allows the user to obtain specific information expeditiously.

1.0 GENERAL DESCRIPTION

Hydrazine is a clear, water-white, hygroscopic liquid with an odor similar to that of ammonia. It is insensitive to mechanical shock and exhibits excellent thermal stability at ambient temperatures.

Hydrazine is considered a hazardous propellant due to its toxicity, reactivity, and flammability. The propellant is harmful when inhaled as a vapor and can cause serious alkali-like burns when the liquid comes in contact with the body. Being a strong reducing agent, hydrazine reacts with oxidizing materials, including common rust, liberating large quantities of energy. In addition, liquid hydrazine at temperatures of 104 F and above, exerts sufficient vapor pressure to form flammable air mixtures. However, when the propellant is stored and handled properly, it need present no serious problems.

Although aqueous solutions of hydrazine are used in various commercial applications, the anhydrous form has thus far been limited to the field of rocket propellants. As a high-energy propellant, the performance of anhydrous hydrazine surpasses that provided by most common fuels such as kerosene, unsymmetrical dimethylhydrazine, ammonia, monomethylhydrazine, and others.

Commercial "anhydrous" hydrazine (97 percent minimum hydrazine concentration, by weight) boils at about 239 F. As a result, it can be stored for long periods of time in compatible low-pressure vessels. Precautions must be taken, however, to maintain the liquid at temperatures above 30 F to prevent the propellant from freezing. In addition, the propellant must be stored under a gaseous nitrogen blanket to prevent oxidation of the propellant and to reduce the vapor flammability hazards.

2.0 PROPERTIES

2.1 General Properties

Since hydrazine is a very hygroscopic substance, its properties are significantly dependent upon the amount of water contamination present. The properties presented herein pertain to either anhydrous hydrazine or commercial hydrazine (97 percent hydrazine and 3 percent water), or in some general cases, to both.

2.1.1 Appearance

Hydrazine is a clear, water-white fuming liquid at room temperature, and will produce white vapors when exposed to moist air.

2.1.2 Odor

Hydrazine has a distinct ammonia-like odor.

2.1.3 Chemical Composition

Hydrazine, as delivered by the manufacturer, contains a minimum of 97 percent hydrazine (by weight), the other constituent being primarily water (MIL-P-26536A).

2.1.4 Solubility

Hydrazine, being a highly polar electrolytic solvent, is soluble in water, methanol, unsymmetrical dimethylhydrazine, and ethylenediamine, but is insoluble in ethers and hydrocarbons.

2.1.5 Chemical Activity

Hydrazine is a caustic liquid having the properties of extreme reactivity as a reducing agent. It reacts with oxidizing

materials, including common rust, and has a tendency to catalytically decompose. Under normal conditions, hydrazine is stable and nonexplosive. At temperatures of 104 F and above, hydrazine exerts sufficient vapor pressure to form flammable air mixtures. The flammability limits of hydrazine in air are from 4.67 to 100 percent, by volume.

2.2 Physicochemical Properties

Property	Anhydrous	97% N_2H_4 - 3% Water
Molecular Weight	32.05	......
Boiling Point	235.9 F	239 F
Freezing Point	34.8 F	30 F
Specific Gravity	1.008 at 68 F	1.012 at 68 F
Density, lb/ft^3	62.93 at 68 F	63.18 at 68 F
Vapor Pressure, psia	0.2 at 68 F	......
Viscosity, $lb_m/ft\text{-}sec$	6.54×10^{-4} at 68 F	6.58×10^{-4} at 68 F
Surface Tension, lb_f/ft	0.00456 at 77 F	......
Critical State Data	716 F	......
	2130 psia	......
	14.6 lb/ft^3	......
Velocity of Sound, in liquid	6857 ft/sec at 77 F	6755 ft/sec at 77 F
Compressibility, adiabatic	1.572×10^{-6} sq in./lb_f at 77 F	......
isothermal	1.746×10^{-6} sq in./lb_f at 77 F	......
Flash Point, (COC)	126 F	......
Heat of Formation, Btu/lb-mol, (l)	21,600 at 77 F	......

2.2 (Continued)

Property	Anhydrous	97% N_2H_4 - 3% Water
Heat of Fusion, Btu/lb	170 at F.P.	......
Heat of Vaporization, Btu/lb	602 at 77 F	......
Heat of Combustion, Btu/lb	8346 at 77 F	......
Heat Capacity Btu/lb-F	0.7358 at 68 F	......
Thermal Conductivity, Btu/hr-ft^2-F/ft	......	0.29 at 77 F

The vapor pressure, specific gravity, and viscosity of hydrazine as a function of temperature are presented in Fig. 1, 2, and 3, respectively.

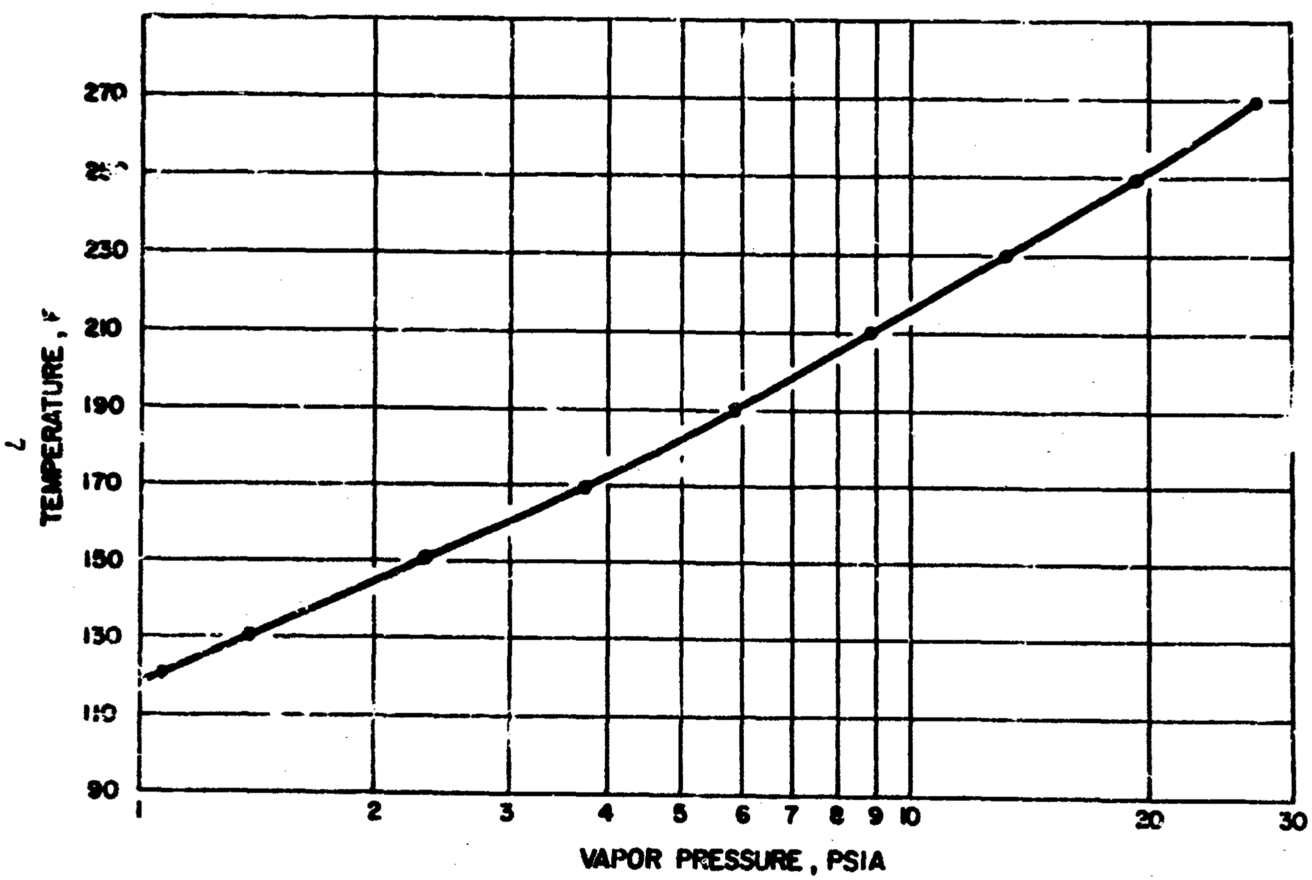


Figure 1. Vapor Pressure of Liquid Hydrazine

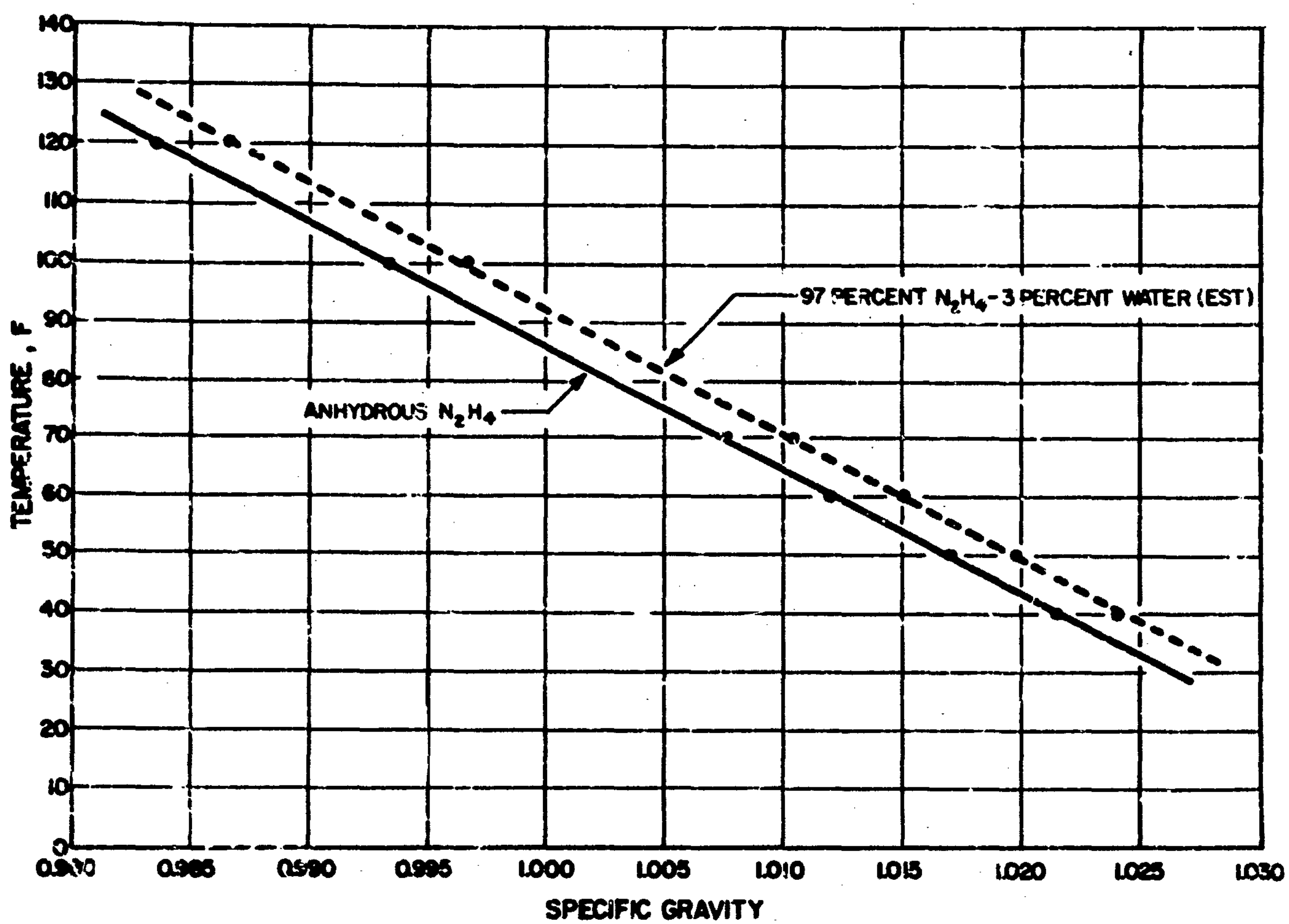


Figure 2. Specific Gravity of Liquid Hydrazine

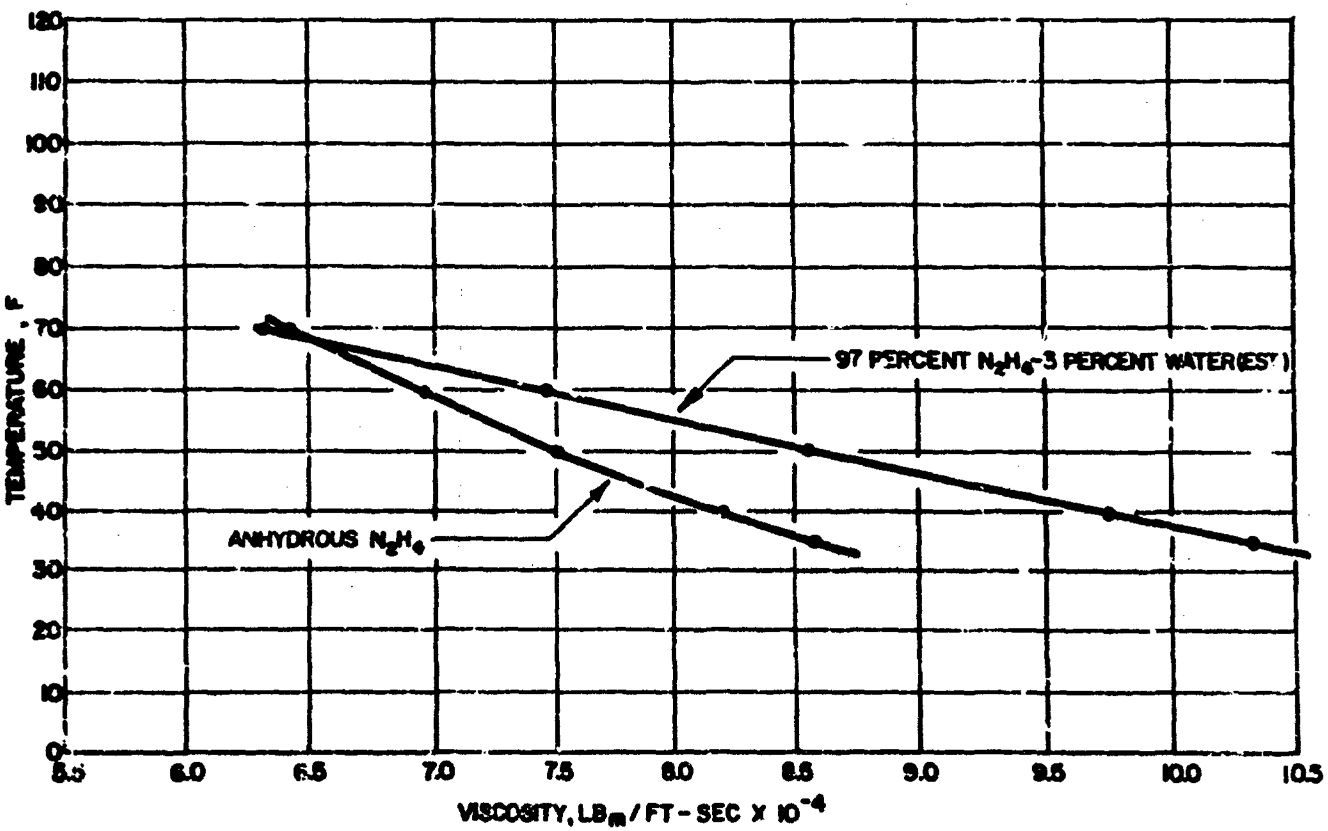


Figure 3. Viscosity of Liquid Hydrazine

3.0 MATERIALS

3.1 Materials Compatibility

Hydrazine is basically compatible with a wide spectrum of materials of construction. However, considerable care must be exercised in selecting suitable materials due to the hazardous properties of the propellant and the necessity to eliminate propellant spills and leaks.

Hydrazine reacts with air, metal oxides, and oxidizing agents, and absorbs water readily. Consequently, the hydrazine transfer and storage systems must be free of air, moisture, rust, and contamination. The lubricants, solvents, and gaskets utilized in these systems must be chemically inert to hydrazine.

3.1.1 Compatible Materials

The following materials and lubricants have been found to be compatible with hydrazine:

Aluminum Alloy No. 1100	Stainless Steel 304
Aluminum Alloy No. 2014	Stainless Steel 321
Aluminum Alloy No. 2024	Stainless Steel 347
Aluminum Alloy No. 4043	Stainless Steel AM-350*
Aluminum Alloy No. 5052	Stainless Steel AM-355*
Aluminum Alloy No. 6061	Stainless Steel 17-7 PH
Aluminum Alloy No. 6066	Iron-Base Superalloy A-286*
Aluminum Alloy No. 356	Inconel
Aluminum Alloy No. B356	Inconel-X
Aluminum Alloy Tens 50	Titanium Alloy Ti-6Al-4V

*These alloys contain over 0.3 percent of molybdenum (Mo) and should not be used at temperatures above 160 F.

3.1.1 Compatible Materials (Continued)

Chromium Plating	Graphite
Kel-F	Dow Corning No. 11
Teflon	Sinclair L743 (MIL-L-25336)
Teflon 100X	

3.1.2 Materials for Limited Service

The following materials have been found to be satisfactory for limited service in hydrazine:

Copper
Nickel
Johns-Mansville Packing No. 76

Since these materials are attacked by hydrazine under some expected conditions or time duration, their use is not recommended.

3.1.3 Incompatible Materials

The following materials and lubricants have been found to be incompatible with hydrazine and must not be used:

K-Monel	Copper Plating
Brass	Micarta
Bronze	Johns-Mansville Packing No. 60
Silver	Viton A
Zinc	Kel-F Elastomer
Cadmium	Mylar
Hastelloy	Buna-N
Electroless Nickel Plating	Hypalon
Cadmium Plating	

3.1.3 Incompatible Materials (Continued)

Neoprene

Saran

PVC (Tygon)

Dow Corning No. 55 (MIL-G-4343)

Oxylube

MIL-L-6086

MIL-L-25336

3.2 Preparation of Materials

All components of a hydrazine storage and/or transfer system must be prepared properly prior to installation. Preparation procedures consist of rendering the components chemically inert to the propellant.

Items such as valves, pumps, etc., cannot be cleaned in the assembled state since solvents may damage nonmetallic components or residues may be trapped in inaccessible areas. Consequently, the cleaning of these items must be done before the component parts are assembled.

The preparation of materials generally consists of degreasing, descaling, passivating, and drying. The cleaning solutions utilized on these operations shall be applied by immersing, spraying, wiping, circulating, or in any other manner, as long as the surfaces to be cleaned are completely wetted in the solutions. Any component which can trap or retain liquids shall be drained or emptied between applications of different cleaning solutions.

All solutions shall be made with distilled, deionized, or clean tap water and all chemicals shall be of chemically pure grade or better. The water shall be filtered through a 40-micron nominal-size filter.

3.2.1 Degreasing

Components fabricated of stainless steel, aluminum, and aluminum alloys can be degreased by cold flushing or vapor degreasing with trichloroethylene, or by flushing with a mild alkaline solution containing from 5 to 7 oz of Turco #4090* (or equivalent) per gallon of water at 140 to 160 F. The application of the mild alkaline solution shall be followed by a thorough water rinse.

Nonmetallic components, such as O-rings, gaskets, etc., shall be degreased by immersion or scrubbing with the mild alkaline solution described above, followed by a thorough water rinse.

Items which are not be cleaned any further, such as nonmetallic components or simple components fabricated of machined metal stock, shall be dried by flushing with dry, hydrocarbon-free, filtered nitrogen gas, or by heating in an oven at 140 to 160 F.

3.2.2 Descaling

Newly fabricated or reworked components which have scale resulting from welding or heat treatment, or impurities resulting from casting or forging, shall be descaled. Descaling solutions should not be used after precision machining, unless the finished surfaces are protected.

*Turco #4090 is furnished by Turco Products, Inc., 6135 So. Central Ave., Los Angeles, California.

The descaling of stainless-steel components is accomplished as follows:

1. Etch at room temperature for a period of no longer than 60 minutes with an aqueous solution containing from 3 to 5 weight percent technical grade hydrofluoric acid and from 15 to 20 weight percent technical grade nitric acid.

2. Rinse thoroughly with water to remove all traces of the descaling solution.

NOTE: If the components are to be passivated immediately after descaling, they need not be dried. Otherwise, the components may be dried by purging with dry, hydrocarbon-free, filtered nitrogen gas or by heating in an oven at 140 to 160 F.

The descaling procedure for components fabricated of aluminum or aluminum alloys is as follows:

1. Clean with Turco Smut-Go* solution (1 lb/gallon of water), or an approved equivalent cleaner, until the surfaces are visibly clean and shiny.

2. Rinse with water to remove all traces of the acid solution.

NOTE: If the components are to be passivated immediately after descaling, they need not be dried. Otherwise, the components may be dried by purging with dry, hydrocarbon-free, filtered nitrogen gas or by heating in an oven at 140 to 160 F.

*Turco Smut-Go is a chromic acid cleaner furnished by the Turco Products, Inc., 6135 So. Central Avenue, Los Angeles, California.

3.2.3 Passivation

The passivation procedure for components fabricated of stainless steel is as follows:

1. Immerse for a minimum period of 30 minutes at room temperature, in an aqueous solution containing from 45 to 55 percent (by weight) technical grade nitric acid.
2. Rinse with water to remove all traces of the passivating solution.
3. Dry by purging with dry, hydrocarbon-free, filtered nitrogen gas or by heating in an oven at 140 to 160 F.

NOTE: Acid passivation of components having highly polished or lapped surfaces may be omitted if the finished surfaces cannot be conveniently protected from the acid solution.

Components fabricated of aluminum or aluminum alloys can be passivated as follows:

1. Immerse for a minimum period of one hour at room temperature in an aqueous solution containing about 45 percent (by weight) technical grade nitric acid.
2. Rinse thoroughly with water to remove all traces of nitric acid.
3. Dry by purging with dry, hydrocarbon-free, filtered nitrogen gas or by heating in an oven at 140 to 160 F.

2.4 Handling

Items that have been prepared for hydrazine service shall be handled, stored, or packaged in such a manner as to prevent recontamination. Large components such as valves, piping sections, tanks, etc., should have all openings capped with clean compatible materials. Small items can be sealed in clean plastic bags.

4.0 HAZARDS

4.1 Toxicity

Hydrazine is very toxic and inhalation of even dilute concentrations should be avoided. Exposure of the skin to liquid or vapor hydrazine should also be avoided. The threshold value, which has been adopted by the American Conference of Governmental Industrial Hygienists, is 1 ppm. This is the maximum allowable concentration (MAC) in which repeated eight-hour-per-day exposure may be safely tolerated by man. Minimum odor detection in air is about 3 to 5 ppm for an average man. Higher concentrations can cause immediate irritation of the eyes and nose. Since hydrazine vapors are known to cause marked olfactory fatigue, the detection of hydrazine by odor can be used only as an initial warning of potential danger. If an individual is exposed to strong concentrations, he should hold his breath, if possible, until fresh air is reached. If unable to do this, breathing should be as shallow as possible. The affected individual should be placed under the care of an authorized physician as soon as possible.

4.2 Physiological Effects

In chronic exposure of test animals to hydrazine vapors, inhalation produced lung damage, inflammation of the liver, inflammation of the kidney, anorexia (loss of appetite), loss in body weight, tremors, weakness, and after prolonged exposure, convulsions followed by death. Lung congestion and edema (accumulation of fluid in the body) appear to be the principal effects of hydrazine, regardless of the administrative method. Some hemolytic (breakdown of red blood cells) action has been noted, but only on the basis of limited experimental work. Data on the effect of

hydrazine on humans have been very limited. Studies by several companies of personnel that have worked with hydrazine over long periods of time have given negative results. This is mainly attributed to the close adherence to established safety rules and precautions.

The effect of hydrazine vapors on the eyes is extremely irritating and will cause itching, swelling, and blistering of the eyelids accompanied by acute pain (very similar to burns caused by a welding arc). Severe exposure may cause temporary blindness, lasting about a day, and several days may be required for complete recovery.

Contact of hydrazine with any body tissue will produce an alkali-like burn. Ingestion or absorption through the skin will cause nausea, dizziness, and headache. Hydrazine is toxic whether administered orally, intravenously, by inhalation, or when applied on the skin.

Any person having accidentally inhaled a significant quantity of hydrazine vapor should be rested immediately and placed in the care of an authorized physician as soon as possible.

If a person has suffered skin exposure to hydrazine liquid, the exposed area should be washed immediately with copious quantities of warm water and soap, or if the eyes are contaminated, flush completely with water. The person should then be placed in the care of an authorized physician as soon as possible.

Following the initial treatment as described above, first aid can be administered as directed by the local medical authority. For

this purpose, it is recommended that at least one person, permanently assigned to the propellant handling area, be properly trained in first-aid techniques. These techniques must be established only by the responsible medical authority.

4.3 Fire and Explosive Hazards

Liquid anhydrous hydrazine is very stable and nonexplosive. In the absence of decomposition catalysts, it has been heated above 500 F with very little decomposition. However, hydrazine vapors present a serious fire hazard. Although its flash point is 126 F, liquid hydrazine at 104 F exerts sufficient vapor pressure to support a 4.7 percent hydrazine-in-air mixture which is flammable. The lower limit of flammability is 4.7 percent and the upper limit is 100 percent by volume. The ignition temperature of hydrazine in oxygen is 400 F, and in air 518 F. Ignition temperatures are much lower in the presence of oxidizers. When two or three drops of hydrazine are dropped on a layer of ferric oxide (a primary constituent of rust) at room temperature, sparks are emitted immediately and the vapor will burst into flame. When hydrazine is dropped on ferric oxide under a nitrogen atmosphere, sparking occurs and the oxide becomes red hot, but flame does not appear until air is introduced. Aqueous solutions of hydrazine are less combustible than anhydrous hydrazine. Solutions containing 40 percent or less hydrazine are noncombustible.

5.0 HAZARD REDUCTION

Spills of hydrazine present a hazard from both intoxication and fire as described in the HAZARDS section. For this reason it is necessary to prevent propellant spills whenever possible and to control safely the spills and fires when they occur.

5.1 Spill Prevention

The prevention of hydrazine spills is one of the most important considerations for the safe handling of the propellant. Spills are the main cause of personnel intoxication and facility damage. Effective spill reduction is accomplished by the use of properly designed equipment and thoroughly trained personnel.

5.1.1 System Integrity

The integrity of the storage and transfer system cannot be overemphasized. The system shall be reliable, flexible, and easy to operate and maintain. Some of the design criteria that shall be incorporated into the system are as follows:

1. Only materials of construction which are definitely known to be compatible with hydrazine shall be employed.
2. The number of mechanical joints shall be reduced to a minimum, thus reducing the probability of propellant leakage.
3. The system shall be designed to withstand the maximum operating pressures safely.
4. The transfer lines shall be free of liquid traps.
5. An inert gas system shall be provided to purge and drain the transfer system without the necessity of dumping the residual propellant or disconnecting any system joints.

6. The valves, gaskets, and instruments used on the system must be reliable, compatible with hydrazine, and properly serviced.

7. The hydrazine vents shall be ducted together and connected to a scrubber or a high vent stack.

8. Sufficient control equipment must be provided to isolate portions of the system and secure transfer equipment during emergencies or components replacement. All remote-controlled equipment shall be designed fail-safe.

9. A gaseous nitrogen blanketing system must be provided to prevent air from getting into contact with the propellant.

10. The transfer and storage system shall be grounded to prevent the buildup of static electricity.

The continual observation of an operational system for possible malfunctions can prevent serious propellant spills. Hydrazine leakage can be detected by the white vapor which is given off by the liquid in air. If leakage is noted, corrective action must be taken as soon as possible.

5.1.2 Trained Personnel

Properly trained personnel are required to handle hydrazine safely. Operating personnel shall be thoroughly familiar with the following:

1. The properties of hydrazine
2. Operation of the transfer and storage system
3. Toxicity and physiological effects of the propellant

4. Operation and use of the safety equipment
5. Fire and spill prevention techniques
6. Fire and spill control measures

NOTE: No person should be allowed to handle hydrazine unless he is thoroughly familiar with the above-listed items and he is also confident that the propellant can be handled safely with the equipment and facilities available to him.

5.2 Fire Prevention

Hydrazine presents a serious fire hazard; thus, all means of fire prevention should be utilized to minimize the hazard.

The flammability of hydrazine vapor can be reduced by the use of diluents. The lower flammability limit may be raised from 4.7 to 38 percent by volume when nitrogen is used as the diluent, or 37 percent when helium is used. This is one of the reasons that all hydrazine storage containers, shipping containers, and transfer lines contain a nitrogen padding; the other reason being the rapid rate of oxidation of hydrazine in air. The air oxidation of hydrazine or the entrance of decomposition catalysts into a hydrazine system can bring about a slow decomposition of hydrazine which liberates heat and raises the temperature of the surrounding surfaces. This process can continue at an increasing rate until the ignition temperature of the vapor is reached.

Hydrazine can ignite upon contact with a highly oxidized surface or material. To prevent fires in case of propellant spillage, the storage and handling areas shall be kept free of all materials that are highly oxidized or are capable of being easily oxidized.

All equipment, tanks, transfer lines, and all other storage area equipment capable of transmitting a spark or building up a static electricity charge shall be properly grounded to prevent the ignition of hydrazine vapors.

Following a hydrazine spill, the hydrazine shall be deluged with copious quantities of water to assure that the hydrazine has been diluted to a concentration lower than 40 percent. Water solutions containing 40 percent or less hydrazine are noncombustible.

Buildings which house equipment for handling hydrazine shall be well ventilated to prevent accumulation of hydrazine vapors.

6.0 HAZARD CONTROL

In case of hydrazine spillage or fire, all personnel shall report to their predesignated safe areas or emergency operating posts. Immediate evaluation of the hazardous situation is necessary so that appropriate control action be initiated in the shortest possible time. The time period between the inception of the hazardous situation and initiation of control action shall be reduced to a minimum. This can be accomplished through proper planning, training, and organization. The following items shall be considered in the administration of the storage and handling areas:

1. Safe areas and evacuation routes shall be pre-established
2. Only authorized personnel shall be allowed to enter these areas
3. At least two operating personnel shall wear protective clothing and equipment during propellant handling operations
4. Periodic drills shall be performed to ensure personnel proficiency during emergency operations

6.1 Spill Control

A hydrazine spill can be most efficiently controlled by performing the following steps chronologically:

1. Stop the propellant handling operations
2. Isolate, by closing the necessary valves, the propellant tanks from the transfer lines
3. Locate the source of spill
4. Isolate the affected components by closing the necessary valves
5. Dispose of the spilled propellant

The performance of the first four steps listed above should be automatic and could be performed in a very short time.

The disposition of the spilled hydrazine can be handled in two ways, depending upon the quantity spilled and the spill conditions.

If small quantities of hydrazine are spilled, it is best handled by deluging the spill area with copious quantities of water and flushing the diluted mixture (below 40 percent N_2H_4) to a catch basin for further disposal.

For cases in which large quantities of hydrazine are spilled and the fire danger is not too great, the hydrazine can be drained to a burn basin where the hydrazine can be safely accumulated and burned. The residual hydrazine in the spill area can then be flushed with copious quantities of water to a catch basin for further disposal. This method is preferred when large quantities are spilled because of the difficulty and expense of chemically disposing of large quantities of hydrazine.

When the fire danger is great, large-quantity spills can be handled in the same way as the small spills.

After the spill is controlled, the area must be properly decontaminated. Decontamination techniques are presented in Section 8.0.

6.2 Fire Control

Hydrazine fires are best controlled by deluging with copious quantities of water. The mechanism by which water extinguishes hydrazine fires is by diluting the propellant to a concentration which

will not support combustion. The water should be applied in the form of a spray in preference to water fog which is less effective due to increased vaporization of the fine droplets in the flame. In addition, water reduces the temperature of the equipment and materials exposed to the fire. Foams and dry chemicals can also be used, but they are less practical than the water-spray technique and there is the possibility of reignition after the extinguishment has been achieved.

7.0 SAFETY EQUIPMENT

The toxicity and chemical reactivity of hydrazine dictate that suitable safety equipment be available for the protection of the storage and handling areas, and operating personnel. Even though the selection of the type and degree of safety equipment depends upon items such as facility design and the various personnel job assignments, it is suggested that one type of safety equipment be specified and enforced. This reduces the misunderstanding among operating personnel as to what degree of protective clothing is required for a specific job assignment, and prevents "short-cut" methods (insufficient protection) which are difficult to control and usually result in serious accidents.

7.1 Facility Safety Equipment

Facility safety equipment shall include emergency showers, eye wash fountains, first-aid kits, water-spray-deluge systems, fire hoses, and fire blankets. The equipment shall be strategically located and easily accessible throughout the storage and handling areas.

All personnel shall be well-informed as to the proper use and location of all safety equipment. The safety equipment must be periodically checked for proper operation. The equipment shall be well-marked and color-coded to conform to standard safety requirements. Hydrazine vapor detectors with alarm systems capable of measuring 1 ppm shall be installed in confined and poorly ventilated facilities.

7.2 Personal Safety Equipment

Personnel handling hydrazine shall wear fully protective equipment. When handling operations are performed either locally or remotely, at least two operating personnel shall be fully protected at all times, so that if a spill occurs, it can be quickly and easily controlled. The following personal protective equipment or its equivalent is recommended:

1. Flameproof coveralls
2. Suit, Gra-Lite
3. Gloves, polyethylene-impregnated
4. Hood, Gra-Lite
5. Boots, Gra-Lite
6. Respirator, self-contained oxygen or air supply unit
7. Communication system, Voice pak

All equipment must be readily available and be maintained clean and in good operating condition. A contaminated suit, for example, can become a definite safety hazard. The operating personnel must have a good working knowledge of the equipment and know its limitations.

8.0 DECONTAMINATION

Decontamination involves the removal of hydrazine from equipment to be serviced, inspected, or replaced, and handling or storage areas following a hydrazine spill. Decontamination procedures are employed to protect equipment and personnel.

8.1 Area Decontamination

Area decontamination operations are performed to remove the residual hydrazine following a propellant spill or fire. This is necessary because of the toxicity of the propellant and the possible ignition or reignition hazard. Area decontamination can be effected by washing the area thoroughly with water. The contaminated solution must be collected in a basin and subsequently disposed of according to local regulations.

8.2 Equipment Decontamination

The removal of residual hydrazine from facility equipment can best be accomplished by flushing the item with copious quantities of water, then purge dry. If the item is to be reused without being modified or serviced, the water used to flush the item shall be distilled, deionized, or clean filtered water.

All items removed from hydrazine service must be clearly labeled, describing the type and extent of decontamination, and the reason for removal.

9.0 TRANSPORTATION

Shipment of anhydrous hydrazine by common carrier is authorized by the Interstate Commerce Commission which classifies hydrazine as a "Corrosive Liquid." The ICC regulations define corrosive liquids as, "Liquids which, when in contact with living tissue will cause severe damage of such tissue by chemical action; or in the case of leakage, will materially damage or destroy other freight by chemical action, or are are liable to cause fire when in contact with certain materials."

Hydrazine may be transported in boxed glass carboys, drums, trailers, and by tank cars in containers specified by the ICC.

The following containers have been ICC-approved and are currently being used by the propellant manufacturer:

1. ICC-1D Boxed glass carboys
2. ICC-5C 30-gallon stainless steel drums
3. ICC-5G 55-gallon stainless steel drums
4. ICC-2695 (Special Permit) Truck-trailer
5. ICC-103C-W 10,000-gallon tank car

Each hydrazine container must bear an ICC-approved white label, "Corrosive Liquid" designation. This label is diamond-shaped with sides 4-inches long, with black printing on a white background. Any material with this label cannot be shipped with explosives or near articles bearing yellow labels.

Railway cars containing one or more packages of hydrazine must be affixed with a "Dangerous" placard.

The ICC specifications and permits for shipment are dependent upon the container design and the methods of shipment. All containers when shipped are closed and protected against leakage and damage by gas-tight protective caps.

10.0 STORAGE

Hydrazine can be stored for periods of several years without adverse effects, either to the storage container or to the propellant, providing the proper materials of construction are used, the container and material are relatively free of contaminants, and the propellant is stored under an inert atmosphere such as dry, hydrocarbon-free nitrogen.

For general storage, the ICC-approved container in which the propellant is transported may be used. For extended bulk storage, stainless-steel tanks, piping and valves should be used.

Hydrazine is classified by the USAF General Safety procedures for Chemical Guided Missile Propellants, 1956 Manual, as a Group 4-C, Combustible (Nitrogen-Hydrogen Compound). This technical order, T.O. 11C-1-6 is the present authority for establishing quantity-distance relationships for storing most of todays liquid rocket propellants. The quantity-distance values presently established for hydrazine storage are presented in Table 1.

Hydrazine should be stored in areas easily accessible, with good natural drainage, near a large water supply, with good prevailing wind movement, and free from combustible materials. Hydrazine storage areas should also be isolated from the storage of oxidizing materials.

TABLE 1

APPLICABLE QUANTITY-DISTANCE VALUES FOR HYDRAZINE

Quantity of Propellant		*Barricaded Distance (feet)		Unbarricaded Distance (feet)		
Pounds Over	Pounds Not Over	Inhabited Building	Magazine Distance	Inhabited Building	Passenger Railway or Public H'way	Magazine Distance(Z)
0	200	100	50	200	110	100
200	1,000	255	50	510	150	100
1,000	5,000	375	75	750	225	150
5,000	10,000	435	100	870	260	200
10,000	20,000	480	125	975	300	250
20,000	50,000	700	150	1.400	420	300
50,000	**100,000	900	200	1,900	545	400
100,000	250,000	1,100	300	2,200	650	600
250,000	500,000	1,400	400	2,800	900	800
500,000	1,000,000	1,700	500	3,400	1,100	1,000

* Barricaded, earth-covered, revetted, or underground
** Maximum permitted for hydrazine.
(Z) For distances from storages (except ready storage) to operating buildings use Service Building distance.

11.0 HANDLING

Handling, as defined herein, includes: handling of shipping containers; transfer of hydrazine; venting; and disposal. Personnel performing direct propellant handling functions, with the exception of handling of the shipping containers, must wear the fully protective equipment described in the SAFETY EQUIPMENT section. The shipping containers can be handled safely without the use of fully protective equipment.

11.1 Handling of Shipping Containers

To avoid shipping container damage or rupture, they must be handled carefully. The container must not be dropped, tumbled, dragged, rolled, or allowed to bump into other containers, walls, or projections.

The containers may be transferred by means of truck, crane, fork-lift, or by any other piece of equipment capable of handling them safely. While in transfer, the container must be firmly secured. The protective caps or plugs must be installed at all times during handling operations.

The containers should be placed in the storage area at the location specified for the type of propellant and container, and clearly marked as to the condition of the container (full, empty, contaminated, etc.).

Any defects which might be noticed in the container upon receipt or prior to shipment should be reported to the responsible personnel for proper disposition.

11.2 Transfer of Hydrazine

Hydrazine can be transferred by using two methods. The propellant can be discharged by pressurizing the container with dry nitrogen gas or by connecting a transfer pump in the discharge line. Both methods have been used with success. The propellant transfer system must be chemically compatible and in good operating condition before use.

In preparing for a transfer operation, all personnel not directly concerned with the operation shall evacuate the hazard area. Appropriate warning lights and signs shall be displayed to keep out unauthorized personnel and to warn of hazardous operations in progress. Personnel performing the transfer operation shall wear the fully protective equipment described in the SAFETY EQUIPMENT section. If the operations are performed remotely, at least two operating personnel shall be fully dressed to facilitate proper spill and fire control. Sufficient safety equipment shall be available for all personnel allowed to remain in the hazard area. Supervisory and emergency support personnel shall be notified prior to executing any hazardous operations in the storage area.

The propellant transfer procedures are dependent upon numerous factors such as transfer system design, type of propellant containers, training of personnel, prevailing weather conditions, etc. Establishing proper operating procedures for each specific situation in a single document is practically impossible. Therefore, the procedures presented are general in nature. <u>The transfer system schematics presented are not finalized designs; they are presented only to facilitate the explanation of typical procedures.</u>

11.2.1 Transfer From Drums (ICC 5C and 5G)

The 30- and 55-gallon-capacity hydrazine stainless-steel drums have two bungholes (2 and 1 in. standard pipe thread) at one end of the drum. The drums have a maximum pressure rating of 5 psig. For both pump and pressure unloading methods, an eductor pipe is required (Fig. 4). This pipe is easily fabricated by drilling a 2-inch standard plug to pass a stainless-steel pipe, and welding the pipe to the plug. The nitrogen gas-supply source can be provided by using an adapter for the 1-inch bunghole or by drilling the 2-inch plug next to the eductor pipe, welding a reducing collar with a 1/4- or 1/2-inch tap to both the pipe and plug (Fig. 5). These welds must be capable of withstanding pressures up to 5 psig.

The propellant is generally unloaded from the drum by pressurizing the container with dry nitrogen gas, but can also be unloaded by connecting a transfer pump in the discharge line. The pressurization technique is preferred because of the low flowrate required in transferring through the small eductor pipe and the small propellant capacity of the drum. Only the pressure unloading method is discussed in detail.

Since the drums as received do not have shutoff valves or eductor pipes, the hydrazine is exposed to the atmosphere when the plugs are removed to prepare the drums for propellant transfer. Therefore, the eductor pipe and pressurizing line should be installed as soon as possible after the plugs have been removed to limit the amount of moisture absorbed by the hydrazine from the atmosphere.

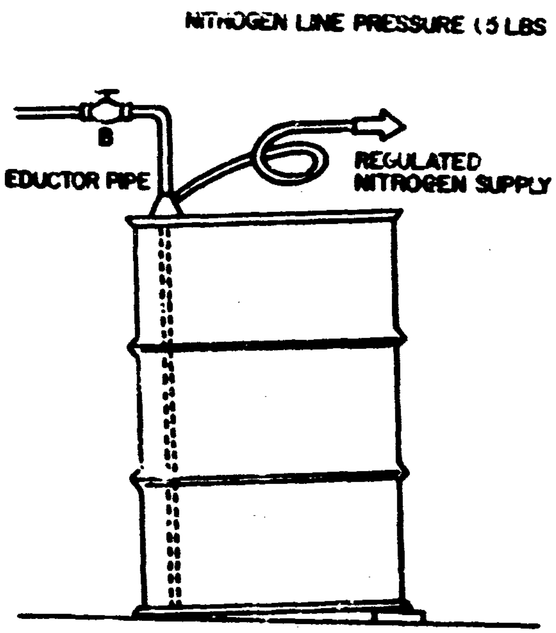


Figure 4. Method for Unloading
Hydrazine from Drums

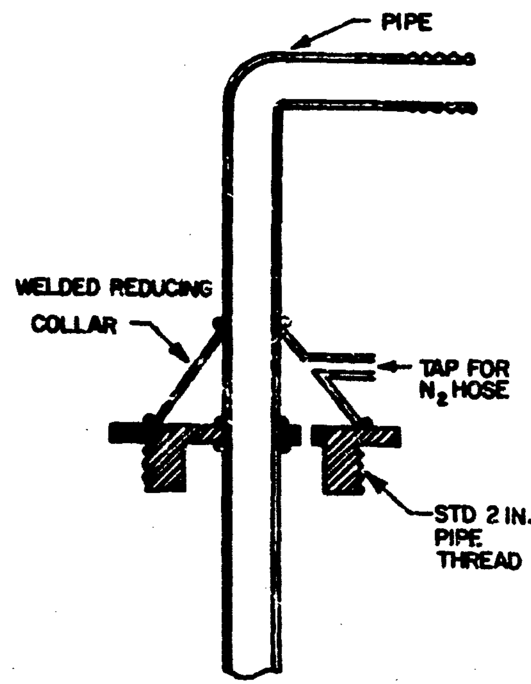


Figure 5. Details of Stainless
Steel Eductor Pipe

The transfer of hydrazine from 30- or 55-gallon drums by the pressure unloading method (Fig. 6) can be performed as follows:

1. Secure the drum in the upright position.
2. Ground the drum.
3. Ensure that all the system valves are closed, except valve 9 which must be maintained open. The object of valve 9 is to prevent the entrance of moisture in case of relief device failure.
4. Cautiously and slowly loosen the 2-inch plug and relieve the pressure in the drum.
5. Replace the 2-inch plug with a clean eductor pipe using a compatible gasket to make an air-tight seal. An air-tight cap should be placed over the exposed end of the eductor pipe prior to installation to prevent the entrance of moisture.
6. Purge the transfer and pressurizing-vent lines for 1 to 2 minutes with dry nitrogen gas at 3 to 4 psig prior to installation by removing the protective caps from the end of the lines and opening valves 1, 2, 5, and 7. (CAUTION: The transfer line may contain residual hydrazine.) After the lines have been purged, close valves 1, 2, 5, and 7, and replace the protective caps if the lines are not to be immediately installed on the container.
7. Attach the pressurizing-vent line to the drum at the 1-inch bunghole or at the tap on the eductor pipe assembly, if so equipped.

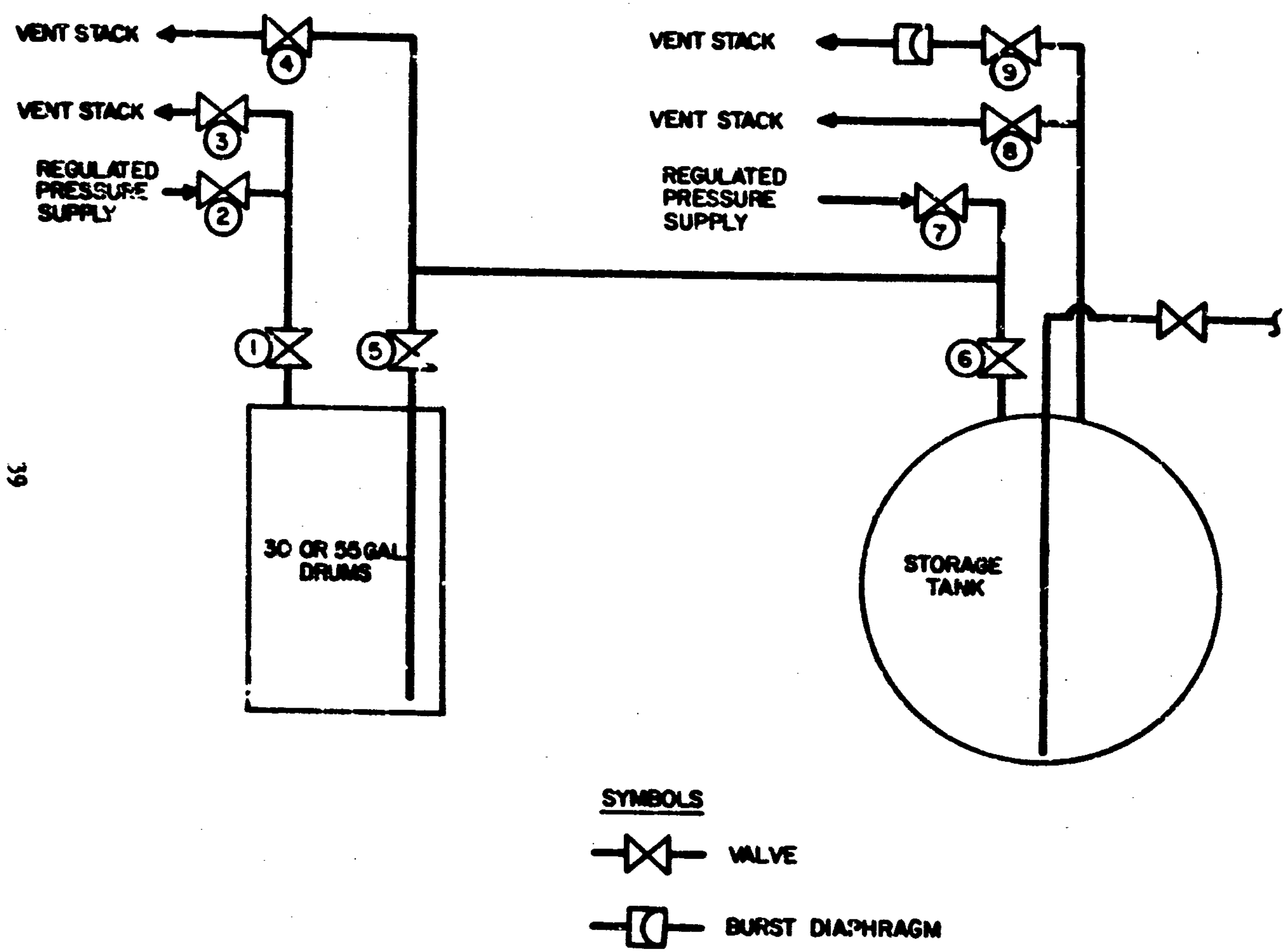


Figure 6. The Transfer of Hydrazine from 30- or 55-gal Drums

8. Place a 2- to 3-inch spacer under the edge of the drum opposite the eductor pipe connection to tilt the drum toward this connection.

9. Remove the protective caps from the eductor pipe and valve 5, and connect the pipe to the valve.

10. Adjust the dry nitrogen gas supply regulator to 3 or 4 psig (maximum is 5 psig).

11. Open valves 1 and 2 slowly and check for leaks. If a leak develops, close valve 2, open valve 3, and take the necessary action to stop the leak (valve 3 must be closed and valve 2 opened before proceeding with step 12).

12. Open valve 5 slowly and check for leaks. If a leak develops, close valve 5, open valve 4, and take the necessary action to stop the leak (valve 4 must be closed and valve 5 opened before proceeding with step 13).

13. Open valve 6 slowly and check for leaks. If a leak develops, close valve 6, open valve 8, and take the necessary action to stop the leak (valve 8 must be closed and valve 6 opened before proceeding to step 14).

14. After valves 5 and 6 have been opened, the propellant flows from the drum into the storage tank until the liquid in the drum is depleted or the pressures in the two containers equalizes. If the pressure in the two containers equalizes, close valve 6 and open momentarily valve 8 to depressurize the storage container. The flow can be resumed by reopening valve 6.

15. When the desired quantity or all of the available hydrazine in the drum has been transferred, close valve 6.

NOTE: There are several devices which can be used to detect the completion of the propellant transfer operation. Combinations of two or more devices are usually required to provide the desired transfer system flexibility. Some of these devices are:

a. A flowmeter installed in the transfer line

b. A scale or other weight-sensing device attached to the drum being unloaded

c. A calibrated level indicator mounted on the storage tank

16. Close valve 2.

17. Open valve 3.

18. Open valve 7 and allow the dry nitrogen gas to purge the transfer line for 2 to 3 minutes.

19. Close valve 7 and allow the pressure in the transfer line and drum to bleed off.

20. Close valves 1, 3, and 5.

21. Remove the pressurizing-vent line from the drum and cap it off. If the 1-inch bunghole was used in pressurizing the drum, replace the adapter with a 1-inch standard plug.

22. Remove the eductor pipe from valve 5, and cap off the pipe and the valve. (CAUTION: The pressurizing-vent line must be removed and the pressure completely bled

off before the transfer line is removed to prevent the spillage of hydrazine if the transfer line is discon nected with pressure in the drum.)

23. Remove the eductor pipe and replace it with the 2-inch standard plug. If the eductor pipe is not to be immediately reused, decontaminate the eductor pipe by flushing it with water.

24. The drum must be properly marked (full, empty, contaminated, etc.) and disposed of according to operating procedures.

25. Notify all personnel concerned that the transfer operation is completed and the area is clear.

11.2.2 <u>Transfer From Tank Cars or Tank Trucks</u>

Tank cars and tank trucks have facilities for top unloading with built-in eductor pipes. A dome and eductor pipe system for a tank car can be seen in Fig. 7. The pressure ratings for tank cars and tank trucks varies according to the individual container design and is generally specified by ICC or state and local codes. Before hydrazine is transferred, the pressure rating of the container must be established and the necessary systems installed or adjusted to prevent overpressurization. Connections on the container may be either flanged, pipe, or AND.

Hydrazine can be unloaded by pressurizing the shipping container with dry nitrogen gas or by connecting a transfer pump in the discharge line. Both transfer techniques are discussed in detail.

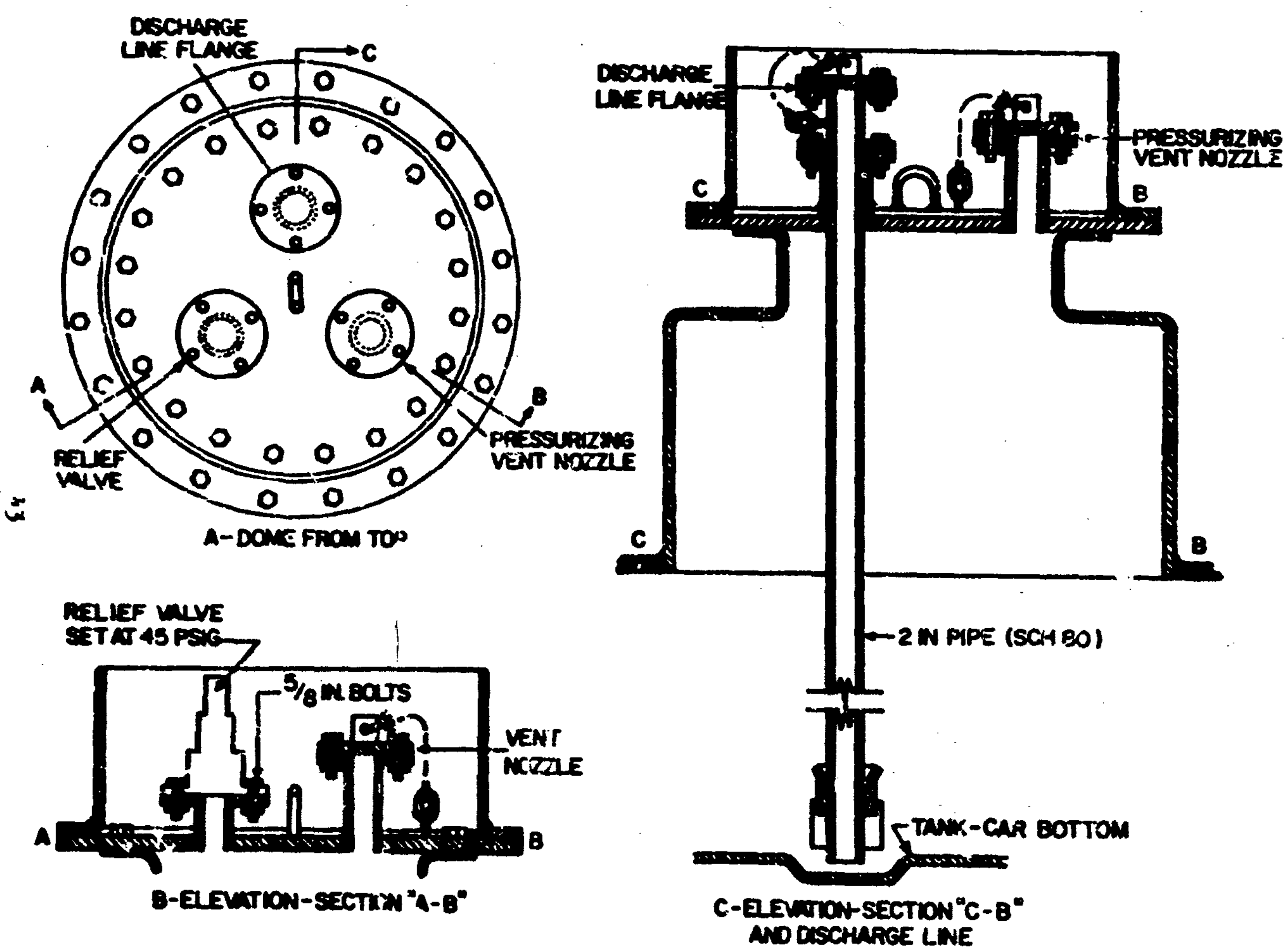


Figure 7. Hydrazine Tank Car Dome and Eductor Pipe Details

The shipping container transfer and pressurizing-vent line protective caps or blind flanges must not be removed until the lines are ready to be installed on the container. This is done to limit the amount of moisture absorbed by the hydrazine from the atmosphere.

The tank cars and tank trucks may contain shutoff valves. The distinction is made in the procedures by dividing the applicable steps into two parts: (a) flanged openings (containers without shutoff valves), and (b) valved openings (containers with shutoff valves).

11.2.2.1 Pressurization Unloading

The transfer of hydrazine from tank cars or tank trucks by the pressure unloading method (Fig. 8) can be performed as follows:

1. Place the tank car or truck-trailer on a level position with the brakes locked and the wheels chocked.

2. Ground the shipping container and bond it to the transfer system to eliminate the possibility of static spark ignition of hydrazine vapors.

3. Ensure that all the transfer system valves are closed, except valve 9, which must be maintained open. The purpose of valve 9 is to prevent the entrance of moisture in case of relief device failure.

4. (a) Flanged openings: Cautiously and slowly loosen the pressurizing-vent nozzle blind flange or cap, and relieve the pressure in the shipping container.

   (b) Valved openings: Verify that the shipping container shutoff valves 10 and 11 are closed.

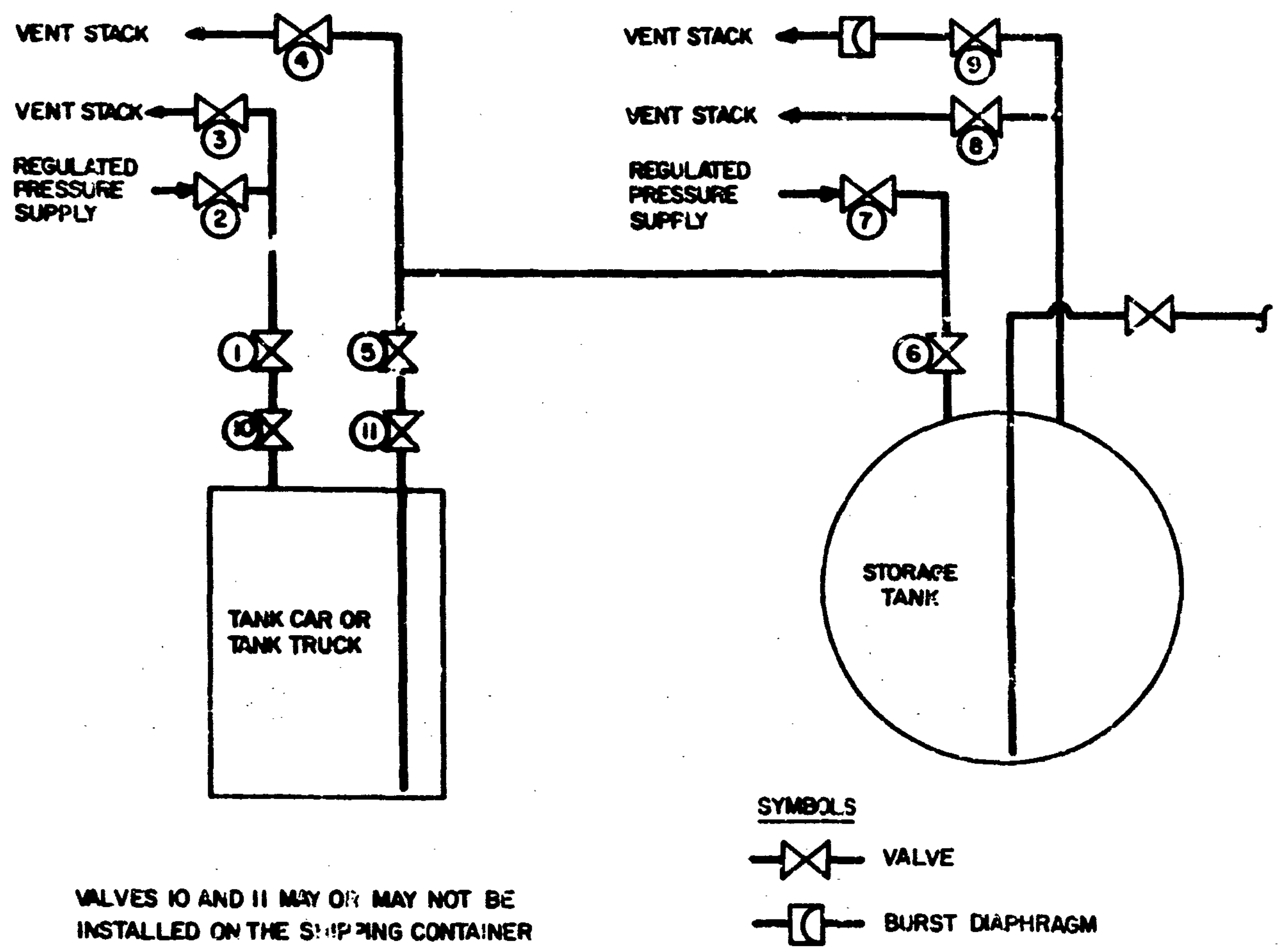


Figure 8. The Transfer of Hydrazine from a Tank Car or

5. Purge the transfer and pressurizing-vent lines with dry nitrogen gas for 1 to 2 minutes at 10 to 15 psig by removing the protective caps from the lines and opening valves 1, 2, 5, and 7. (CAUTION: The transfer line may contain residual hydrazine.) After the lines have been purged, close valves 1, 2, 5, and 7, and reinstall the protective caps if the lines are not to be immediately installed on the shipping container.

6. (a) Flanged openings: Remove the shipping container discharge nozzle blind flange or cap and connect the transfer line using a compatible gasket to make an air-tight seal. (CAUTION: The pressure in the shipping container must be completely bled off prior to removing the discharge nozzle flange or cap to prevent the spillage of hydrazine if the flange or cap is removed with pressure in the container.)

   (b) Valved openings: Remove the protective caps from the transfer line and valve 11, and connect the line to the valve.

7. (a) Flanged openings: Remove the pressurizing-vent nozzle blind flange or cap, and connect the pressurizing-vent line to the nozzle using a compatible gasket to make an air-tight seal.

   (b) Valved openings: Remove the protective caps from the pressurizing-vent line and valve 10, and connect the line to the valve.

8. Adjust the dry nitrogen gas supply regulator to a pressure that will provide a reasonable rate of propellant

flow. Precautions must be taken to assure that the maximum pressure rating of the containers and transfer system is not exceeded.

9. If the shipping container contains shutoff valves, open valves 10 and 11.

10. Open valves 1 and 2 slowly and check for leaks. If a leak develops, close valve 2, open valve 3 and take the necessary action to stop the leak (valve 3 must be closed and valve 2 opened before proceeding with step 11).

11. Open valve 5 slowly and check for leaks. If a leak develops, close valve 5, open valve 4, and take the necessary action to stop the leak (valve 4 must be closed and valve 5 opened before proceeding with step 12).

12. Open valve 6 slowly and check for leaks. If a leak develops, close valve 6, open valve 8, and take the necessary action to stop the leak (valve 8 must be closed and valve 6 opened before proceeding with step 13).

13. After valves 5 and 6 have been opened, the propellant flows from the container into the storage tank until the liquid in the shipping container is depleted or the pressures in the two containers equalizes. If the pressure in the two containers equalizes, close valve 6, and open valve 8 momentarily to depressurize the storage tank. The flow can be resumed by reopening valve 6.

14. When the desired quantity or all of the available hydrazine in the shipping container has been transferred, close valve 6.

NOTE: There are several devices which can be used to detect the completion of the propellant transfer operation. Combinations of two or more devices are usually required to provide the desired transfer system flexibility. Some of these are:

(a) A flowmeter installed in the transfer line

(b) A scale or other weight-sensing device placed under the tank car or tank truck being unloaded

(c) A calibrated level indicator mounted on the shipping container and/or storage tank

15. Close valve 2.

16. Open valve 3.

17. Open valve 7 and allow the nitrogen gas (10 to 15 psig) to purge the transfer line for 2 to 3 minutes.

18. Close valve 7 and allow the pressure in the transfer line and shipping container to bleed off.

19. Close valves 1, 3, and 5. If the shipping container contains shutoff valves, close valves 10 and 11.

20. Remove the pressurizing-vent line from the shipping container and cap it off.

21. (a) Flanged openings: Allow the pressure in the shipping container to completely vent off, and then install a blind flange or cap on the pressurizing-vent nozzle.

(b) Valved openings: Cap off the pressurizing-vent nozzle.

22. (a) Flanged openings: Remove the transfer line from the shipping container discharge nozzle and install a blind flange or cap on the nozzle and transfer line. (CAUTION: The pressure in the shipping container must be completely bled off prior to removing the transfer line in order to prevent the spillage of hydrazine if the line is removed with pressure in the container.)

(b) Valved openings: Remove the transfer line from the shipping container discharge nozzle and cap the line and nozzle.

23. The shipping container should be properly marked (full, empty, contaminated, etc.) and disposed of according to operating procedures.

24. Notify all personnel concerned that the transfer operation is completed and the area is clear.

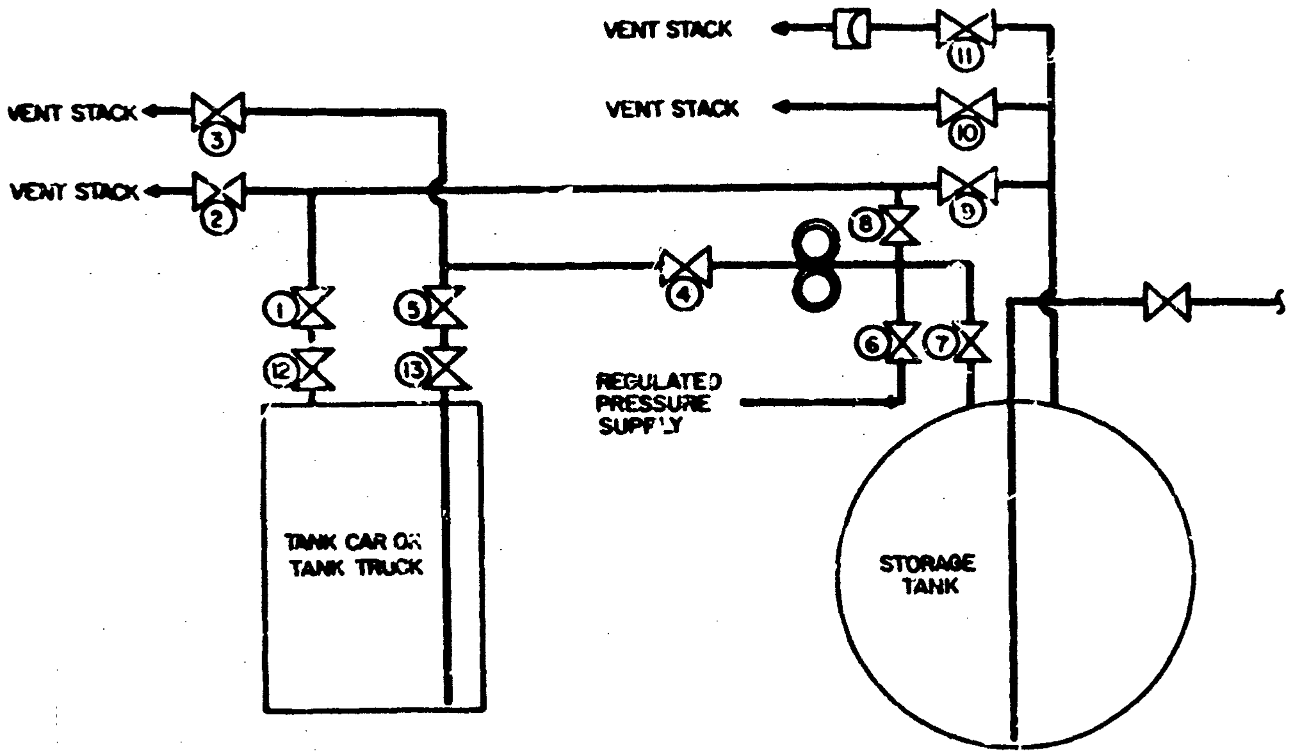
11.2.2.2 <u>Transfer Pump Unloading</u>

The transfer of hydrazine from tank cars or tank trucks by the transfer pump unloading method (Fig. 9) can be performed as follows:

1. Place the tank car or tank truck on a level position with the brakes locked and the wheels chocked.

2. Ground the shipping container and bond it to the transfer system to eliminate the possibility of static spark ignition of hydrazine vapors.

3. Ensure that all transfer system valves are closed, excep valve 11, which must be maintained opened. The purpose



VALVES 12 AND 13 MAY OR MAY NOT BE
INSTALLED ON THE SHIPPING CONTAINER

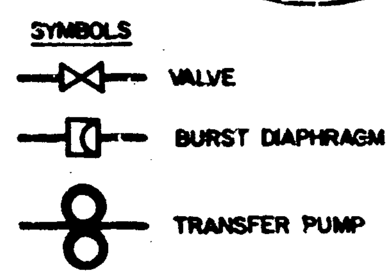


Figure 9. The Transfer of Hydrazine from a Tank Car or Tank Truck by the Transfer Pump Unloading Method

of valve 11 is to prevent the entrance of moisture in case of relief-device failure.

4. (a) Flanged openings: Cautiously and slowly loosen the pressurizing-vent nozzle blind flange or cap, and relieve the pressure in the shipping container.

   (b) Valved openings: Verify that the shipping container shutoff valves 12 and 13 are closed.

5. Purge the transfer and pressurizing vent lines for 1 to 2 minutes with dry nitrogen gas at 10 to 15 psig, by removing the protective caps and opening valves 1, 4, 5, 6, and 8. (CAUTION: The transfer line may contain residual hydrazine.) After the lines have been purged, close valves 1, 4, 5, 6, and 8, and reinstall the protective caps if the lines are not to be installed immediately on the shipping container.

6. (a) Flanged openings: Remove the shipping container discharge nozzle blind flange or cap, and connect the transfer line using a compatible gasket to make an air-tight seal. (CAUTION: The pressure in the shipping container must be completely bled off prior to removing the discharge nozzle flange or cap in order to prevent the spillage of hydrazine if the flange or cap is removed with pressure in the container.)

   (b) Valved openings: Remove the protective caps from the transfer line and valve 13, and connect the line to the valve.

7. (a) Flanged openings: Remove the pressurizing-vent nozzle blind flange or cap, and connect the pressurizing-vent line to the nozzle using a compatible gasket to make an air-tight seal.

   (b) Valved openings: Remove the protective caps from the pressurizing-vent line and valve 12, and connect the line to the valve.

8. Adjust the dry nitrogen gas supply regulator to 10 - 15 psig.

9. If the shipping container is equipped with shutoff valves, open valves 12 and 13.

10. Open valves 1, 6, and 8 slowly, and check for leaks. If a leak develops, close valve 6, open valve 2, and take the necessary action to stop the leak (valve 2 must be closed and valve 6 opened before proceeding with step 11).

11. Open valve 5 slowly and check for leaks. If a leak develops, close valve 5, open valve 3, and take the necessary action to stop the leak (valve 3 must be closed and valve 5 opened before proceeding with step 12).

12. Close valves 6 and 8.

13. Open valves 4 and 7 slowly, and check for leaks. If a leak develops, close valve 4, open valve 10, and take the necessary action to stop the leak (valve 10 must be closed and valve 4 opened before proceeding with step 14).

14. Start the transfer pump.

15. Open valve 9.

NOTE: If the transfer pump has lost its prime, reprime the pump as follows:

(a) Stop the transfer pump.

(b) Close valves 4, 7, and 9.

(c) Open valve 10 momentarily to depressurize the storage tank; valve 10 must be closed before proceeding with step d.

(d) Open valves 6 and 8, and allow the shipping container to pressurize to 10 - 15 psig.

(e) Close valves 6 and 8.

(f) Open valves 4 and 7.

(g) Start the transfer pump.

(h) Open valve 9.

16. When the desired quantity or all of the available hydrazine in the shipping container has been transferred, stop the transfer pump and close valves 7 and 9.

NOTE: There are several devices which can be used to detect the completion of the propellant transfer operation. Combinations of two or more devices are usually required to provide the desired transfer system flexibility. Some of these are:

(a) A flowmeter installed in the transfer line

(b) A scale or other weight-sensing device placed under the tank car or tank truck being unloaded

(c) A calibrated level indicator mounted on the shipping container and/or storage tank

17. Open valves 2 and 6, and allow the dry nitrogen gas at 10 to 15 psig to purge the transfer line for 2 to 3 minutes.

18. Close valve 6 and allow the pressure in the transfer line and shipping container to vent off.

19. Close valves 1, 2, 4, and 5. If the shipping container contains shutoff valves, close valves 12 and 13.

20. Remove the pressurizing-vent line from the shipping container and cap it off.

21. (a) Flanged openings: Allow the pressure in the shipping container to completely vent off, and then install a blind flange or cap on the pressurizing-vent nozzle.

(b) Valved openings: Cap off the pressurizing-vent nozzle.

22. (a) Flanged openings: Remove the transfer line from the shipping container discharge nozzle and install a blind flange or cap on the nozzle and transfer line. (CAUTION: The pressure in the shipping container must be completely vented off prior to removing the transfer line to prevent the spillage of hydrazine if the line is removed with pressure in the container.)

(b) Valved openings: Remove the transfer line from the shipping container discharge nozzle and cap the line and nozzle.

23. The shipping container should be properly marked (full, empty, contaminated, etc.) and disposed of according to operating procedures.

24. Notify all personnel concerned that the transfer operation is complete and the area is clear.

11.2.3. Transfer From Storage Tanks

The procedures for transferring hydrazine from storage tanks to use or shipping containers would be similar to the procedures as outlined in sections 11.2.1 and 11.2.2.

11.3 Venting

The depressurization of hydrazine systems occurs quite frequently. Because of the low vapor pressure of the propellant, venting hydrazine systems does not present a serious problem. Two basic methods are generally used for handling the propellant vapor. These methods are:

1. The transfer system vent lines are connected to a scrubber system which removes the propellant vapor from the vent gases. Many types of scrubbers and solutions for absorbing the propellant vapors can be used. The most common is the water scrubber.

2. A vent stack which discharges the vented gases at least 50 feet above the highest working point in the area. In some cases, a nitrogen gas or air purge is installed in the vent stack to dilute the hydrazine vapors before being discharged into the atmosphere.

The second method is generally preferred because of the increased chances of contaminating the transfer system with water and the added handling operation in disposing of the dilute solutions of hydrazine from the scrubber.

11.4 Disposal

Disposal involves the controlled release of hydrazine from a storage, use, or shipping container into a system capable of disposing of the propellant safely, and then disposing of the propellant. The following items are essential for the proper selection and safe operation of a hydrazine disposal area.

1. The disposal area shall be isolated in accordance with the quantity-distance table presented in the STORAGE section.
2. The disposal area shall be clear of trees, weeds, brush, and other combustibles.
3. The area must be provided with adequate facility safety equipment (See SAFETY EQUIPMENT section).
4. One person shall never be allowed to work in the disposal area alone.
5. The personnel safety equipment described in the SAFETY EQUIPMENT section must be worn during disposal operations.
6. All personnel not participating in the disposal operation shall evacuate the area.
7. Disposal operations shall be performed only under controlled conditions.

The following methods are usually employed for disposing of hydrazine:

1. Burning. The burning of hydrazine is generally conducted in a small, concrete-lined pit. Hydrazine and aqueous solution of hydrazine are placed in the pit by means of a pipe or surface channel. The hydrazine can be ignited

by an igniter (squib-fired), an oxidizer such as nitrogen tetroxide, a torch, etc. Concentrations as low as 40 percent by weight hydrazine in water can be burned. Concentrations lower than 40 percent can be burned by enriching the dilute mixture with a soluble flammable liquid such as alcohol.

2 Neutralization. The neutralization process is generally applied to concentrations below 15 percent by weight hydrazine. Neutralization is accomplished by the addition of compounds such as hydrogen peroxide or calcium hypochlorite to the dilute solution. The neutralization products can then be diluted with water below the maximum allowable concentrations, as determined by state and local codes, and released.

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Rocketdyne, a Division of North American Aviation, Inc., Canoga Park, California, HYDRAZINE HANDLING MANUAL by E. Suarez-Alfonso, A.E. Chambers, and D.J. Hatz, September 1961, 57 p incl. illus. (Proj. 3148, Task 30196) (AF/SSD-TR-61-7) (Contract AF33(616)-6939) Unclassified report	1. Hydrazine 2. Safe handling of liquid propellants 3. Liquid propellants I. Suarez-Alfonso, E. II. Chambers, A.E. III. Hatz, D.J.
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